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# Similarity and Complementarity of Airborne and Terrestrial LiDAR Data in High Mountain Regions

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Glacier melt and a consequential increased sediment transport (erosion, transportation and accumulation) in high mountain regions are causing a frequent occurrence of geomorphic processes such as landslides and other natural hazards. These effects are investigated at the Gepatschferner (Kaunertal, Oetztal Alps, Tyrol), the second largest glacier in Austria, in the PROSA project (Catholic University Eichstätt – Ingolstadt, Vienna University of Technology, Friedrich Alexander University Erlangen-Nürnberg, Martin-Luther-University Halle-Wittenberg, University of Innsbruck, Munich University of Technology). To monitor these geomorphic processes, data with a very high spatial and very high temporally accuracy and resolution are needed. For this purpose multi-temporal terrestrial and aerial laser scanning data are acquired, processed and analysed.

Airborne LiDAR data are collected with a density of 10 points/m$^2$ over the whole study area of the glacier and its foreland. Terrestrial LiDAR data are gathered to complement and improve the airborne LiDAR data. The different viewing geometry results in differences between airborne and terrestrial data. Very steep slopes and rock faces (around 90°, depending on the viewing direction) are not visible from the airborne view point. On the other hand, terrestrial viewpoints exhibit shadows for areas above the scanner position and in viewing direction behind vertical or steep faces. In addition, the density of terrestrial data is varying strongly, but has for most of the covered area a much higher level of detail than the airborne dataset. A small temporal baseline is also inevitable and may cause differences between acquisition of airborne and terrestrial data.

The goal of this research work is to develop a method for merging airborne and terrestrial LiDAR data. One prerequisite for merging is the identification of areas which are measurements of the same physical surface in either data set. This allows a transformation of the airborne to the terrestrial data (or vice versa) without introducing systematic errors caused by the above mentioned differences. A workflow for this analysis is established with command line processing of the point clouds using OPALS (Orientation and Processing of Airborne Laser Scanning data, Vienna University of Technology). For further processing of the data, it is necessary to adjust the different scans by using least squares matching of surfaces to improve the orientation of the ALS and TLS data.

Handling of the terrestrial LiDAR data with its very high point density and the data filtering to minimize errors and artefacts turned out to be the biggest challenges. After a relative and absolute orientation of the TLS scans with the help of GNSS spheres (see P. Glira, ESSI1.5), the data are processed in order to make it comparable with the airborne LiDAR scans. Different ranges and consequential different footprint sizes and a big variance of the point densities have to be considered. Therefore the application of different filter and interpolation methods is important to get the best results and in further consequence to calculate an ideal Digital Terrain Model (DTM), which provides a good input dataset for future modelling of the geomorphic processes in the PROSA study area around the Gepatschferner.